Durham University Evidence Centre for Education

An evaluation of Code Club

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Citation: Siddiqui N., Gorard, S., See, B.H., and Gazmuri, C. (2024). *An evaluation of Code Club: Report*. Durham University Evidence Centre for Education.

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Executive summary

The project

Code Club is a volunteer-led initiative run by the Raspberry Pi Foundation (RPF). The club activities are usually after-school programmes which offer opportunities for young people aged 9 to 13 to learn and develop skills for coding. The Raspberry Pi Foundation can provide Code Clubs with free resources, projects, and tutorials to help volunteers and learners get started with coding and computing.

The Foundation creates and disseminates educational materials, including a structured curriculum for clubs. These materials are designed to make learning to code fun and accessible. Young people create their own digital artefacts using skills and resources available in Code Club sessions. Code Clubs aim to provide a fun, informal, and collaborative environment where pupils and teenagers can learn to code and develop digital skills. The programme also aims to improve pupils' non-cognitive skills by creating opportunities for practicing coding, knowledge about digital literacy and engagement with a wider community of young people who are interested in coding and programming skills. Club leaders/volunteers come from a wide range of backgrounds. Many are teachers who run Code Clubs as after schools or lunchtime clubs, but others are parents or people from the community, some of whom have a technical background. Some may volunteer to become Code Club leaders and advance their skills while teaching and mentoring young people.

This new project evaluates the impact of Code Club on young people's attitudes to general learning, to learning about coding, and performance in coding skills. It is run by the Durham University Evidence Centre for Education (DECE) - Durham University Evidence Centre for Education - Durham University/.

The independent evaluation is a quasi-experiment in which 15 schools and one community library participated. Young people as Code Club members were compared with their peers who did not participate in the Code Club after-school activities. This included 412 pupils who were in Years 4 to 9 initially.

The evaluation assessed impact outcomes using pre and post intervention surveys of non-cognitive learning attitudes and performance in a quiz on coding skills. The headline results are based on the gain scores of pupils' attitudes to learning and quiz. In addition, a light-touch process evaluation was conducted to observe and report on other aspects such as reasons for and level of pupils' participation in Code Club activities, Code Club leaders' reasons for and experiences of volunteering for the Code Club, and challenges and barriers of running a club in schools and other sites such community libraries.

How secure are the findings?

The findings have a moderate (to low) degree of security for all outcomes. The study is a quasi-experiment with a high dropout rate (43%), so the results should be interpreted with some caution. In the pre-test stage 18 schools and one community library participated, generating an initial sample of 417 pupils. At the post-test stage 13 schools were retained, and only 239 pupils could be linked for complete analysis. The pupil dropout rate is 40%, which is high given the 22 weeks of the study. The pupil survey of attitudes and coding quiz were conducted first in the beginning of Autumn 2023 and later at the end of Spring 2024. The survey and quiz were administered via an online platform controlled by the research team members and therefore the process was independent of the developer's involvement. The survey was piloted in schools before the quasi-experiment started in September 2023. The pool of questions for the quiz of coding skills was provided by RPF, and the research team selected the items for pre and post rounds of the quiz. Although the survey and quiz are bespoke

instruments, the items were carefully and systematically selected from various other standardised instruments, with a track record of use in large-scale studies.

What are the main findings?

This study suggests promising results for pupil learning attitudes and coding skills if they choose to attend Code Club as an after-school activity. In learning attitudes pupils showed some improvement in 'resilience', 'confidence' and 'belonging'. The improvement in learning of coding skills also showed evidence of promise.

Summary of impact on primary outcome

Group	"effect size"
Quiz of coding skills	+0.24
Gains in 'Resilience'	+0.22
Gains in 'Confidence'	+0.47
Gains in 'Belonging'	+0.09

In terms of feasibility of implementation, Code Club after-school sessions were attractive to pupils who are interested in learning coding, and schools and other settings can run Code Club offered by RPF, with help from Code Club volunteer leaders. The major constraint could be the availability of volunteering Code Club leads who have the confidence or skills, and the time, to help young people with coding.

Summary of conclusions

Key conclusions
1. Participation in Code Club after-school activities shows promise for pupils' attitudes in general learning ('Resilience') and learning coding ('Confidence' and 'Belonging'). There are encouraging signs in other attitudes such as 'Problem Solving', 'Communication' and 'Creative Thinking' that were not pre-specified.
2. Participation in Code Club after-school activities shows encouraging signs for pupils' performance in the quiz of coding skills.
3. Code Club is feasible to run as a voluntary activity managed by Code Club leaders. Activities were enjoyable for pupil participants. School premises were popular and active sites for Code Club after-school activities, and we involved one community library Code Club, which was less frequently attended by young people.
4. In general, young people who chose to attend the after-school Code Club sessions enjoyed coding and developing creative digital projects.

Acknowledgements

We would like to acknowledge the support of all those who contributed to the success of this research study. Our appreciation goes to the 18 schools and community libraries that participated. Their willingness to dedicate time and resources to conducting the pupil online survey and providing important data has been invaluable. A special thanks goes to all of the pupils who took the time to complete the survey. Their input is the cornerstone of this research, and their perspectives have provided us with essential insights.

We are particularly grateful to the Code Club leaders, whose support, invaluable feedback, and first-hand experiences in running and managing Code Clubs, enriched this research significantly. They have not only supported the data collection process but also offered a deeper understanding of the practical aspects of Code Clubs.

An evaluation of Code Club

Introduction

The intervention

The Raspberry Pi Foundation (RPF) promotes digital literacy and education in computing. To make computing accessible for young people, RPF designs learning experiences and products for young people and provides resources and support to educators, in order to develop young people's skills and confidence in using technology creatively.

The Foundation runs several educational programmes and initiatives supporting learning for young people. One such programme is Code Club for young people aged 9 and above, which provides structured educational materials, projects, and resources for Code Club members. This report concerns Code Clubs in the UK. The volunteering community of teachers, pupils, mentors, and experts in programming skills play a key role in running the Code Club sessions. RPF manages a free website for Code Club members to which the organising institutions such as schools, community libraries, and learning centres have free access. This website provides a platform for organising institutions, with training sessions and events to foster collaboration where knowledge and experiences of coding and programming skills can be shared.

Code Club leaders provide support to help young people progress through digital projects, enabling them to create games, animations, and web pages using Scratch, Python, or HTML/CSS. The projects introduce coding concepts step by step, allowing young people to gradually build their knowledge and experience in coding skills. Adults running the clubs do not need to be highly experienced coders, as many volunteers only facilitate the process and learn coding alongside the club members.

Code Club members can participate in events such as competitions, and exhibitions and showcase the creative potential of computing. The purpose of these activities is to promote knowledge of, and skills for, coding, and inspiring young people in problem-solving and innovation. Pupils' participation in Code Club activities is intended to motivate their learning through collaboration and communication with other Code Club members who share a common interest in coding and programming skills. Pupils showcase their digital artefacts at Code Club events and collaborative activities, and the purpose is to motivate their general learning skills and enhance their interest and experience in coding.

Brief background

The development of programming and computational thinking skills for young pupils is considered as a new form of literacy and is receiving increasing attention (Strawhacker et al. 2018). Coding can be studied as a general problem-solving mechanism and as a process that allows users to create shareable products (Bers 2020). Many coding applications and educational programmes have been designed for improving the development of children's communication (Sung et al. 2017), teamwork and engagement (Critten et al. 2022, Fessakis et al. 2013).

A review of previous studies synthesised findings from 24 selected articles suggesting that coding activities can improve children's computational thinking in early childhood years and that there are no specific gender differences in motivation for learning coding (Baati 2022). Many application tools have been developed and implemented for pupil's learning of coding skills and are recognised for developing logical thinking and problem-solving skills in a fun and engaging way (Rich et al. 2024). There are educational benefits for teaching young children coding, and problem-solving skills, from using diverse interfaces and styles (Rose and Jay 2017). However, studies give very mixed results on the effectiveness of coding tool on pupils' actual learning outcomes (Stamatios 2024).

A review by Papadakis (2021) suggested a positive impact of coding apps on pupils' thinking skills. However, the review was based on relatively weak evaluations. Another systematic review by Popet and Tarkey (2019) synthesised findings from 10 selected studies and indicated positive outcomes frm coding on children's non-cognitive skills. The selected studies did not have an appropriate causal design; therefore the impact results cannot be conclusive about pupils' non-cognitive outcomes.

Code Club, part of the Raspberry Pi Foundation (RPF), has been previously evaluated in a school-based randomised control trial, conducted with 34 primary schools involving 317 pupils in year 5. This found a small positive effect (+0.04) using an independent measure of computational logic, and a bigger impact (0.17) on coding skills (Straw et al. 2017). Pupils' attitudes to use of computers, coding for personal development, and coding for future aspirations and careers were also assessed as secondary outcome measures. The findings suggested promising impact on these attitudes. The dropout rate was 46% which makes the study findings less robust. Therefore, there is a research gap in terms of large-scale evaluations of Code Club as a process and activity, especially in terms of pupil enjoyment, and attitudes to coding, and the impact on coding skills.

Research questions

This new evaluation answers the following main research questions:

1. What is the impact of attending Code Club on pupils' attitude to general learning ('Resilience') and to -learning coding skills ('Confidence' and 'Belonging')?
2. What is the impact of attending Code Club on performance in a quiz of coding and programming skills?

Ethical review

Ethical approval was provided by the Durham University School of Education Ethics Committee. The project was conducted in accordance with the British Educational Research Association's 'Revised Ethical Guidelines for Educational Research' (2018). There was assured anonymity and confidentiality for all participants. No individual pupil or school is identified or identifiable. Schools and individual organisations obtained opt-out parental consent for taking part in activities, and to be part of the evaluation.

Project team

The evaluation team at Durham University Evidence Centre for Education (DECE) led all aspects of the evaluation. The evaluation team included the following members.

- Professor Nadia Siddiqui
- Professor Stephen Gorard
- Professor Beng Huat See
- Carolina Gazmuri

For the purpose of evaluation, Code Club recruitment and participation was managed by the following team members of Raspberry Pi Foundation (RPF).

- Ben Durbin (Head of Impact)
- Hammad Kazi (Impact analyst, left October 2023)
- Tamasin Greenough Graham (Head of Code Club)
- Zoe Davidson (Community Engagement Manager)

Design and methods

Evaluation design

This evaluation was based on a quasi-experimental design assessing pupils who participated in the Code Club intervention, or not. Schools and community libraries were invited to take part in the study. Code Club is an after-school activity in which pupils choose to participate. Therefore, their peers from years 4 to 10 formed the natural comparison group, together with one school not running Code Club. Because of initial differences between Code Club members and others, the design used progress scores between pre- and post-intervention surveys, and so is a difference-in-difference (DiD) design.

In response to a recruitment call, interest in participation was received from schools and community libraries where Code Club was running regularly as an after-school activity. There was a potential for spill-over from the intervention within schools so we also recruited a school which did not run Code Club as an after-school activity. This school formed a clean comparison group in the analysis, along with the non-attendees from schools who were running Code Club. Pupils attended Code Club, at least in part, in the period from October 2023 to April 2024, whereas non-attending counterparts and the control school continued business as usual.

Participating schools and organisations

School recruitment was managed by RPF, and the DECE team provided the recruitment call templates, the Memorandum of Understanding (MOU) framework, and ethics proformas for parental consent. RPF received interest from 53 schools/Code Clubs. However, only 15 schools and 1 community library engaged fully and signed the MOU. Participating schools agreed to conduct the survey and coding skills quiz for whole classes, providing a natural comparison with pupils who did not choose to participate in Code Club.

All schools who had shown interest and/or signed the MOU were sent a link with an email request to implement the pupil survey and coding skills quiz with all those in Years 4 to 9 who were eligible to participate in Code Club.

For a clean comparison, schools in the list of those waiting to join Code Club activities were invited to take part in the evaluation. Initially six comparison schools showed interest, but only one actually participated in the evaluation and was still involved at the post-survey stage.

Figure 1 shows the geographical distribution of all Code Club and comparison schools who participated in the study.

Figure 1: A map of Code Club locations

Outcome measures

Primary Outcomes

RPF and DECE agreed on the evaluation plan of assessing impact outcomes related to pupils' general learning attitudes (in general and specific to learning coding) and their coding skills. DECE, in consultation with RPF, developed and piloted an instrument including items on pupil attitudes to general learning and coding skills. RPF pre-specified the following items as primary impact outcomes for the study.

- Resilience - I keep trying even when a task is difficult.
- Confidence to learn independently - I am good at learning coding by myself.
- Belonging - I know people like me who think coding is interesting.

Performance in a quiz of coding skills is also a primary impact outcome of this evaluation. We also report further attitude outcomes (to problem-solving, communication, creative thinking, and interest in coding), and discussions with students.

The results of the impact outcomes are analysed as gains scores instead of absolute scores. The comparison groups of Code Club and Non-Code Club members were not balanced at the outset in terms of average age and baseline scores in attitudes and coding skills. Therefore, analysing results as gain scores as difference from pre to post intervention phases is most appropriate.

Secondary Outcomes

The process evaluation informs many of the secondary outcomes for this study. The secondary outcomes are concerned with dosage in the form of implementation models, use of Code Club website resources, organisation of pupil groups/pairs, length of the sessions, and support provided for running the club. The process evaluation involved semi-structured and informal interviews with Code Club leaders, seeking information on their experience and perceptions of pupils' engagement in Code Club activities.

Instruments

The survey of young people's learning attitudes

The Code Club programme may lead to improvements in pupils' attitudes to learning in general, and more specifically in attitudes to learning coding. These non-cognitive attitudes are assessed through a suitable instrument and by comparing the responses of member and non-members before and after experiencing Code Club.

The survey items were adapted from previous evaluation studies. The set of items on learning attitudes was adapted from our prior evaluation surveys and the Student Computer Science Attitude Survey (SCSAS). After discussions with RPF, we selected items in two domains of general learning attitudes and attitudes to learning coding. Table 1 shows the items used in the pilot studies, their item difficulty at grade level and standard of readability judged by a text readability calculator. Following the pilots, we removed the items concerning meaningfulness and impact.

Table 1: The survey items

	No. of items	Readability Year Group/ Grade level	Readability standard (Good, Average, Poor)
General learning attitudes			
Problem solving	2	6	Good
Resilience	2	6	Good
Communication	2	6	Good
Creative thinking	2	6	Good
Teamwork	2	5	Good
Engagement	2	5	Good
Attitudes to learning Coding			
Confidence to learn independently	4	5	Good
Belonging	2	5	Good
Interest	5	5	Good
Meaningfulness	2	5	Good
Impact	2	5	Good

Note: The bold items are pre-specified primary outcomes for the study.

All items in the attitudes survey are stand-alone, and have clear audit trails leading to their derivation. The widely held belief that measurement error can be reduced by making respondents repeatedly answer the same question is an error (Gorard 2010). The key consideration was that the items were measurable, malleable in individuals, and deemed important by stakeholders - either in their own right or because they are linked to attitude outcomes including participation in after-school learning activities. The instrument was tested for suitability such that all pupils could respond with minimal assistance and as appropriate for the range of reading age of Year 4 pupils and above.

Coding skills quiz

A quiz of 25 multiple choice questions on applying coding skills was developed by experts in the RPF team, assisted by DECE. The quiz had two slightly different versions at the same level, to be administered at pre and post stages. The evaluation team guided the process of item construction and independently managed the online administration and analysis of pre and post quiz results. The evaluation team conducted a pilot to check the feasibility of the Qualtrics platform for an online quiz of coding skills. On average the combined online survey and quiz took 25-30 minutes of an individual's time to complete.

Table 2 shows a summary of the characteristics of the two versions of coding quiz implemented as pre and post stages. They were very similar, with similar results.

Table 2: Coding quiz-Pre and Post survey

	Quiz score Pre-survey	Quiz score Post-survey
Mean	7.89	7.95
Standard deviation	4.00	3.96
Minimum score	0	1
Maximum score	19	19
Average completion time	25 minutes	17 minutes
N	248	239

The pre and post attitude surveys also included accounts of pupils' use of programming languages (Scratch, Python and HTML). Pre and post survey differences in the frequency of language use can be associated with the experience of attending Code Club or not, and with the quiz results. The results for this item are not primary outcomes, and are reported in Appendix C.

The surveys and quiz were collected over a number of weeks both at the outset and the end. It is, therefore, interesting to consider whether the elapsed time between tests was related to the test results. 67% of the respondents had a period of three months between pre and post-test. The correlation between the number of months elapsed and the quiz score, for example, was -0.097. This yields a very small R squared value, so there is no clear link between the two, even though those with a longer lapse scored fractionally worse, on average.

Interviews

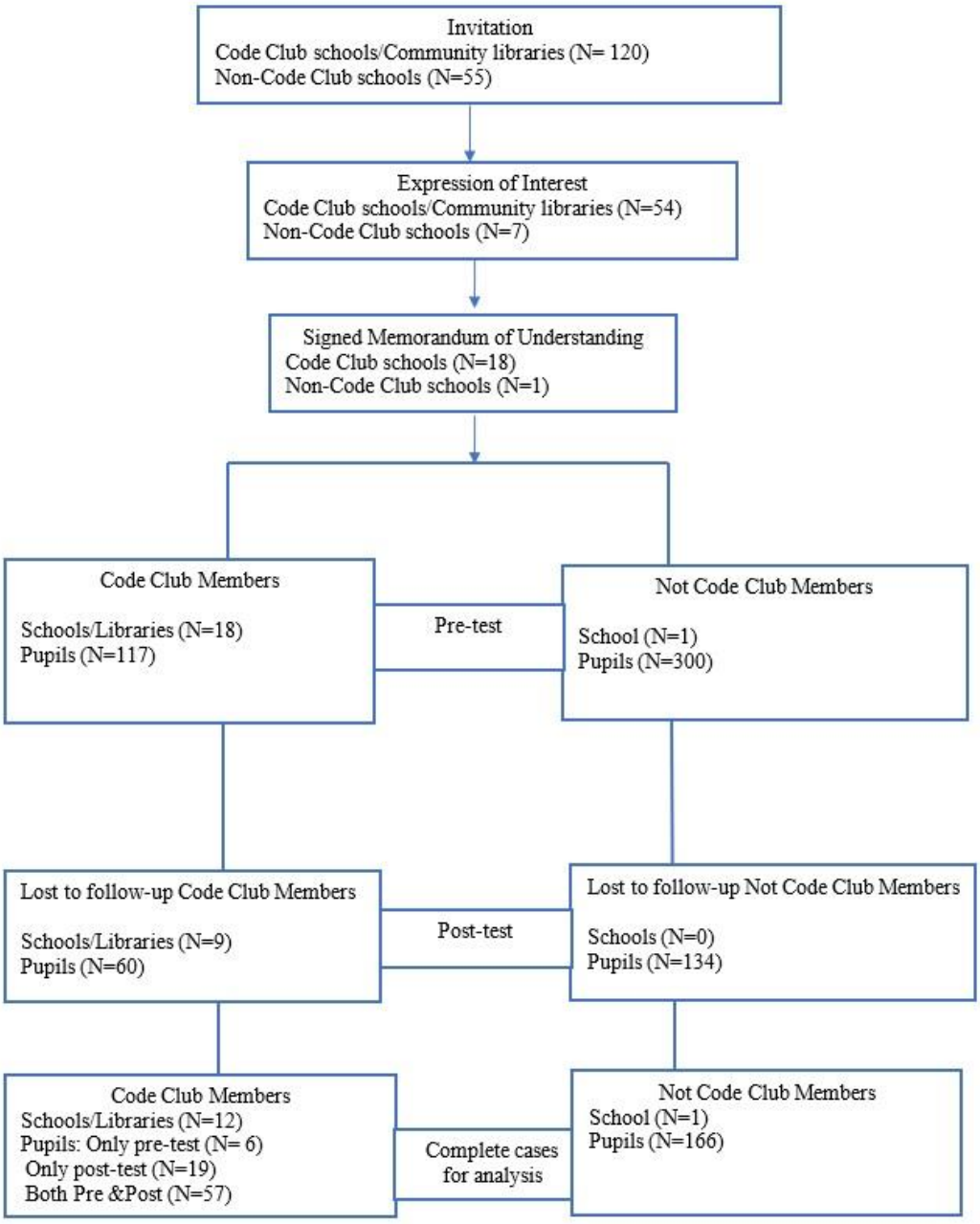
We developed an interview schedule for collecting data on secondary outcomes of the evaluation study. The interviews were informal discussions usually lasting no more than 20 minutes in which five Code Club leaders shared their experience of running the clubs. The interview schedule covered the objectives of running a Code Club, format of the Code Club, and general experience of pupils and Code Club leaders. We identified common themes related to the objectives of running Code Club.

Interviews were also used to collect the narratives of pupils, teachers, and Code Club leaders with firsthand experience of the activities. By exploring the perspectives of pupils, teachers, and Code Club leaders, the study gained deeper insights into the factors influencing participation decisions. Additionally, the feedback and experiences shared by pupils regarding their Code Club sessions were analysed to understand their learning preferences and identify elements that may have enhanced their overall learning journey. The information is useful to report on older pupils volunteering as mentors, participation from parents, community engagement from Code Club leaders, and pupils' experience of learning as a Code Club member.

Sample

RPF issued an invitation to Code Club leaders to participate in the study and initially received expressions of interest from 60 primary and secondary schools and other settings. 15 schools and 1 community library actually took part. At the post-survey phase only 13 schools engaged in the study and implemented the post-survey. The pre-survey included pupils in Years 4 to 10 – a total of 412. The post-survey response was considerably lower, and only 274 pupils participated in the survey. We could only link 248 pupils in the pre and post surveys, and these form the group for complete analysis. The pupil dropout rate is 40% of the initial sample which is high and a threat to the generality of the findings of the study. See Figure 2 for the participant flow diagram.

Figure 2: Participant flow chart



The 13 schools recruited and maintained throughout could be considered a relatively small sample. However, the ability to detect any impact will be considerably enhanced by the large number of observations (pupils) taken for each school estimate, and the high correlation between pre- and post-test outcome scores. Also, the quasi-experiment involved non-cognitive outcomes which are generally less structurally and socio-economically stratified than attainment, and the effect sizes possible for wider outcomes are likely to be higher than for performance in the quiz of coding skills (Gorard and Smith 2010).

Table 3 shows the characteristics of the achieved sample, at each stage, and overall.

Table 3: The sample

	Pre-survey	Post-survey	Complete Cases
Pupils	412	274	248
Girls	187	131	113
Boys	216	125	130
Missing Gender	9	18	5
Year 3	2	0	0
Year 4	11	3	3
Year 5	106	78	72
Year 6	246	160	146
Year 7	43	31	26
Year 8	3	0	0
Year 9	1	0	0
Schools/Community libraries	18	12	9
Members Code Club (Pre and Post)	113	80	57
Not Member Code Club (Pre and Post)	299	176	166

The headline findings compare only those pupils who had both pre and post survey results available. This was intended to improve the estimate of the effect on the outcomes since only some pupils in schools participated and we cannot know which pupils in the control school would have done so if given the chance. There were only 57 pupils who chose and stayed in Code Club in the pre and post survey stages, whereas 166 pupils in pre and post-test stages reported did not choose to attend Code Club. The comparison group of Non-Code Club members is bigger than the Code Club members. Therefore, the smaller group will determine the security level of the results.

Methods of analysis

The pre-agreed primary attitude outcomes were Resilience (*I keep trying even when a task is difficult*), Confidence to learn coding independently (*I am good at learning coding by myself*), Belonging (*I know people like me who think coding is interesting*) and performance in coding skills for the Code Club members after around 22 weeks of receiving the treatment.

The analysis compares changes in the pre-specified outcomes of interest between the intervention and comparison group – a Difference-in-Difference (DiD) approach. The before and after differences between the two groups are reported as 'effect sizes' obtained from the gain scores in the attitude and coding skills quiz outcomes. The headline results are the effect sizes for the gain scores because the pre-survey results showed considerable imbalance, with the Code Club members clearly ahead at the outset (see results section). Therefore, the headline results are presented as effect sizes of progress from pre-survey to post-survey stages.

Where the outcome measures are real numbers, or can be treated as real numbers (such as with the 11 scaled attitude items – see Appendix A), any differences between the two groups are converted into a Hedge's effect size.

We also conducted regression models (see below), using pre-survey scores and Code Club participation status as the predictors and subsequent post-survey performance as the dependent variable. However, simulations of large numbers of trials show that the substantive results based on progress scores and R, R-squared or standardised coefficients from one-step regression models are the same on all occasions (see also Xiao et al. 2016). This is so, as long as the correlation between pre- and post-intervention scores is high (as it is here at around +0.7) and similar across quasi-experiments. So, put simply, if the correlation is high and static (as here) it does not matter to the results which approach is used, and progress scores are preferred because they are easier to understand.

Nevertheless, we do present regression models as well, but these are the preferred two-step models. The same approach is used for the headline attitude outcomes, and for the same reasons.

Please note that none of the analyses include significance tests, confidence intervals or similar figures as these are inappropriate and completely misleading with these non-randomised cases (see, for example, Falk and Greenbaum 1995, Hubbard and Meyer 2013, Colquhoun et al. 2014, Gorard 2021). Because standard errors are not relevant it follows that clustering is also not relevant. It has been shown in repeated comparative analysis that the actual headline effect sizes are unrelated to clustering. We have only one estimate for each 'effect' size, and so cannot provide a standard deviation for these, by definition. Anything else used as a purported measure of uncertainty, such as a 'standard deviation' formed by repeated sub-sampling of the full dataset, would merely be a complex way of portraying the scale of the difference, the variability of scores (both encapsulated in the 'effect' size already) and the scale of the study (N for each treatment group, as already reported).

Instead, the headline results are presented with a simple sensitivity analysis – the number of counterfactual cases needed to disturb the finding, or NNTD (Gorard 2021). This can be computed by multiplying the achieved 'effect' size by the number of cases in the smallest group, and then comparing it to the number of missing cases. If the answer is clearly greater than the number of missing cases, then the finding cannot be due to biased missing data. The larger the answer is the more secure the finding is.

Many of the supplementary analyses are in Appendix B. None is a substitute for the simple headline results.

Subgroup Analysis
We also present descriptive findings on the attendance rate of Code Club members in relation to their outcomes in attitudes, and performance in the quiz of coding skills. These findings only suggest a correlation between voluntary participation in after -school Code club and subsequent outcomes. There is no comparison group of pupils in this analysis, therefore the findings must be interpreted with caution.

Pupils who participated in the pre-survey, but whose post-survey data is missing, are counted as missing or dropout cases. At the post survey stage 178 cases are missing which is a 40% attrition rate. Descriptive analysis of the missing cases presents the average difference of pre-survey attitude scores and coding quiz between those who dropped out of the study and those who were retained.

Process evaluation methods

The process evaluation provided formative evidence on all phases and aspects of Code Club implementation from the selection and retention of schools and Code Clubs, through to the survey and quiz which are the eventual outcomes. This was used to help assess fidelity to treatment, implementation issues, and the perceptions of participants, including any resentment or resistance. It also enables us to identify the features of successful implementation as well as highlighting potential barriers.

The process evaluation includes:

- Informal interviews with pupils and parents
- Observations of the out-of-school hours activities in a Code Club
- Interviews with the Code Club leaders
- Close reading of the Code Club website to understand the objectives of the programme.
- Regular updates on the features and activities followed.

Code Club is not strictly a structured activity or curriculum in terms of delivery. Code Club leaders plan their own goals and session activities, usually following the module instructions and resources available on the Code Club website. For the purpose of evaluation, the Code Club leaders were the primary contact with the participating schools, so the implementation of the online survey and quiz were managed by the Code Club leaders. Observation of one Code Club after-school activity was first recorded as handwritten field notes by the evaluation team members who conducted the school visit. The evaluator team member developed a report of the visit which included detailed descriptions of the field notes, teachers' feedback and comments and details about conversations with the pupils. All reports were shared and read by the evaluation team members and important themes and issues were extracted and synthesised for reporting.

Timeline

Table 4 presents a summary of the stages and timing of this evaluation.

Table 4: Outline of timeline

Date	Activity
March – June 2023	• Pupils survey and Coding Skills quiz were designed • Invitation to schools and Code Clubs for participation
July 2023	• The survey-quiz was piloted in a school which was not part of the evaluation group
August 2023	• Report on pilot of pupil attitude survey submitted to RPF • Final school recruitment for the evaluation • Recruitment of comparison school
September- November 2023	• Parental consent sought by the schools • Baseline launch of attitude survey and coding skill quiz using Qualtrics • Code Club after-school activities began
December 2024- February 2024	• Interviews with Code Club leaders • Observation of a Code Club session
March- April 2024	• Post-survey and coding skills quiz implementation using Qualtrics
May- June 2024	• Stopped data collection and chasing schools who were not responding • Online attitude survey and coding skills quiz closed for respondents. • Final data downloaded and cleaned for analysis • Preliminary findings were shared with RPF • Findings shared with Code Club leaders and RPF staff for their feedback
July 2024	• Final report published

Impact evaluation findings

This evaluation is based on a non-random sample of volunteering schools and Code Clubs. The descriptive analysis of the complete cases gives an understanding of pupils' general learning attitudes, learning coding, and performance on coding skills. For all results, the safest comparisons are based on gain scores and not absolute scores.

Descriptive findings

For the main analysis indicating the possible impact of Code Club on pupils learning, we draw comparison between two sub-groups who reported being a member and received Code Club activities in both pre and post survey (57), and their counterparts who reported no membership of the Code Club activities in either survey (166). The pre-specified items that were selected as primary outcomes appear in bold.

Table 5 presents standardised mean differences ('effect sizes') illustrating to what extent Code Club members gained in general attitudes to learning compared to their peers who reported no exposure to Code Club activities in both pre and post survey. After considering the negative phrasing of one item, Code Club members show higher gains than non-members in all items. This includes the pre-specified resilience item (+0.24).

Table 5: Effect size of gains in attitudes to general learning (N=223): Only two sub-groups

	Not a Member in Pre and Post survey- Gain Average	Member Pre and Post surveys- Gain Average	Overall standard deviation	ES
Problem solving				
When I have a problem, I break it down into smaller problems to solve	-5.39	-5.16	4.44	+0.05
I enjoy trying to solve problems	-0.53	0.89	3.26	+0.44
Resilience				
I keep trying even when a task is difficult	-0.53	0.23	3.13	+0.24
I do not like to spend time on difficult tasks	0.22	-0.34	4.22	-0.13
Communication				
I am good at explaining my ideas to other people	-0.59	0.96	3.16	+0.49
Creative thinking				
I like to ask questions that other people have not thought of	-0.55	0.57	3.86	+0.29
I like to suggest new ideas	-0.30	0.46	3.86	+0.21
N	166	57		223

This is not a randomised control trial, and the groups were not equivalent at the outset, so any differences in outcomes cannot simply be attributed to attendance at Code Club or not. There were 417 respondents at the outset, and only 239 here with both pre and post scores. This means that 178 cases are missing. The number of counterfactual cases needed to disturb (NNTD) the headline finding about resilience in Table 4 is 14. The number of missing cases is considerably greater than NNTD, and so there is a strong chance that these results are not secure (Gorard 2021).

Table 6 shows standardised mean differences ("effect sizes") illustrating to what extent code club members gained in attitudes to learning coding compared to their peers who reported no exposure to Code Club activities in pre and post survey. On average, Code Club members made greater improvements in all attitude to coding items (once the negatively phrased item is reversed). And again this includes both pre-specified items in bold.

Table 6: Effect size of attitudes to learning coding (N=223): Only two sub-groups

	Not a Member in Pre and Post survey- Gain average	Member Pre and Post surveys- Gain average	Overall standard deviation	ES
Confidence to learn independently				
I feel confident when coding	-1.10	-0.12	3.01	+0.33
I feel anxious when I am asked to write code	0.50	-0.37	3.43	-0.25
I am good at learning coding by myself	-0.59	0.96	3.16	+0.49
Belonging				
I know people like me who think coding is interesting	-0.60	-0.21	3.79	+0.10
Interest				
I like coding	-1.11	-0.18	3.10	+0.30
I like coding to solve problems	-0.35	0.41	3.42	+0.22
I would like to learn more about coding	-0.77	-0.26	3.02	+0.17
I like using coding to create projects	-1.05	-0.39	3.72	+0.18

There was an additional item in the post-test "I get on well with others when I am learning coding in a group". This was not in the pre-test and therefore a gain score is not possible.

NNTD for the independence item is 28, and for the belonging item it is six, and so again there is a need for caution.

The last primary outcome of the study is performance in the coding quiz. Table 7 presents standardised mean results for performance in coding, as measured by the quiz of coding skills. The comparison is between members of Code Club who reported participation in Code Club in both pre and post surveys against those who reported no membership. This analysis is not based on gains in individual items, because the questions changed pre and post. The "effect" size for Code Club members is +0.24, again suggesting a higher gain for Code Club members (perhaps not surprisingly, for coding). Therefore, Code Club members are ahead for all four pre-specified measures.

Table 7: "effect size" coding quiz by Code Club membership pre and post surveys

	Pre-survey	Post-survey	Gain score	Standard deviation	"effect" size
Code Club pre and post	9.18	9.55	0.37	3.36	+0.24
Never Code Club	7.59	7.12	-0.47	3.56	
Overall	8.06	7.95	-0.11	3.53	

The NNTD here is 13 cases, meaning that the results must be treated with caution.

These results can be examined in slightly more detail by also considering those cases who reported being a member of Code Club only at either the start (6) or the end (19). This gives us four comparison groups. Tables 8, 9, and 10 show the differences between pupils in general attitudes, attitudes to learning coding, and quiz scores for these four groups. Note, these do not alter the headline findings. These results tend to show that there are better outcomes for the groups with any membership of Code Clubs, even if only temporary.

Table 8: Average gains of four groups: Attitudes to general learning (N=248)

	Not a member Pre and Post	Member Pre and Post	Member Pre only	Member Post only
Problem solving				
When I have a problem, I break it down into smaller problems to solve	-5.39	-5.16	-5.33	-3.82
I enjoy trying to solve problems	-0.53	0.89	0.20	0.68
Resilience				
I keep trying even when a task is difficult	-0.53	0.23	-2.00	-0.05
I do not like to spend time on difficult tasks	0.22	-0.34	-0.75	1.95
Communication				
I am good at explaining my ideas to other people	-0.59	0.96	-2.00	-0.79
Creative thinking				
I like to ask questions that other people have not thought of	-0.55	0.57	-0.80	0.21
I like to suggest new ideas	-0.30	0.46	-1.20	0.58
N	166	57	6	19

Note: "effect" sizes are computed with respect to those 'Never attended Code Club'

Where the gain/progress scores are negative, this means that a sub-group had a lower mean score after the intervention period than before. This is a relatively common phenomenon in education, and is not to be confused with items such as "I do not like to spend time on difficult tasks", which are negatively phrased. The first item in Table 7 shows negative gains for all groups, but the greatest "loss" of reported problem-solving ability is for those not involved in Code Club at all.

Table 9: Average gains of four groups: Attitudes to learning coding (N=248)

	Not a Member in Pre and Post survey	Member Pre and Post surveys	Member Pre only	Member Post only
Confidence to learn independently				
I feel confident when coding	-1.10	-0.12	-1.60	0.47
I feel anxious when I am asked to write code	0.50	-0.37	2.00	-0.84
I am good at learning coding by myself	-0.59	0.96	-2.00	-0.79
Belonging				
I know people like me who think coding is interesting	-0.60	-0.21	-1.80	-0.16
Interest				
I like coding	-1.11	-0.18	-1.00	0.21
I like coding to solve problems	-0.35	0.41	-0.40	0.35
I want to learn more about coding	-0.77	-0.15	1.00	1.47
I like using coding to create projects	-1.05	-0.39	-0.20	-0.20

Table 10: “effect size” coding quiz by Code Club membership pre and post surveys

	Pre-survey	Post-survey	Gain score	Standard deviation	“effect” size
Code Club pre only	10.00	10.67	0.67	3.01	+0.32
Code Club post only	8.12	9.53	1.41	3.59	+0.53
Code Club pre and post	**9.18**	**9.55**	**0.37**	**3.36**	**+0.24**
Never Code Club	7.59	7.12	-0.47	3.56	
Overall	8.06	7.95	-0.11	3.53	

Experiences of only Code Club Members

In this section we report on the experiences of Code Club members. In the post-test some additional items were included only for Code Club members to assess the level of their engagement in Code Club activities, measured by their self-reported attendance. Only 66 Code Club members completed this section of the survey. There is no comparison group here. Most learners reported attending for “most weeks”.

The results are somewhat mixed (Tables 11 and 12). Although the most frequent attenders had better outcomes for several items, sometimes the small number of cases with less frequent attendance reported higher gains (including for the coding quiz). In general though, these findings tend to support the idea that attendance at Code Club is beneficial in terms of attitudes.

Table 11: Average gains in learning attitudes by frequency of matched cases attending Code Club at post survey

	Less than once a month	Once or twice a month	Most weeks
Problem solving			
When I have a problem, I break it down into smaller problems to solve	-7.00	-3.00	-5.07
I enjoy trying to solve problems	0.00	1.05	1.04
Resilience			
I keep trying even when a task is difficult	0.40	0.25	0.43
I do not like to spend time on difficult tasks	-1.40	5.00	-0.42
Communication			
I am good at explaining my ideas to other people	-1.60	-3.25	1.00
Creative thinking			
I like to ask questions that other people have not thought of	-0.80	-3.75	1.11
I like to suggest new ideas	-1.40	-1.50	0.84
Confidence to learn independently			
I feel confident when coding	0.40	-0.25	0.61
I feel anxious when I am asked to write code	-0.20	-0.75	-0.66
I am good at learning coding by myself	-1.60	-3.25	1.00
Belonging			
I know people like me who think coding is interesting	-3.80	0.50	0.42
Interest			
I like coding	-2.20	-1.75	0.22
I like coding to solve problems	-1.20	-0.25	0.91
I want to learn more about coding	3.60	-0.25	0.17
I like using coding to create projects	-3.20	-1.00	-0.38
N	5	4	56

Table 12 shows that pupils with least attendance, less than one per month, gained highest in the programming quiz. The number of cases in this sub-group is very small. Therefore, the results are inconclusive about the actual level of attendance in Code Club activities and gains in the coding quiz.

Table 12: Average gains in quiz by self-reported attendance in Code Club activities

Attendance	N	Average Gains	Standard Deviation
Less than once a month	5	2.50	13.44
Once or twice in a month	4	0.75	2.63
Most weeks	56	0.80	3.18

Table 13 shows pupil reported reasons for choosing to become Code Club members. Most pupils joined for intrinsic reasons, related to learning programming skills, and not because others told them to.

Table 13: Why joined Code Club? (N=66)

	Average	Standard Deviation
I enjoy coding	8.29	2.75
To learn more about coding	8.84	2.00
Because knowing coding will be useful in future	7.90	2.81
Because my friend joined	2.58	3.33
Because my teacher or parent told me to	1.60	2.92

Note: as with the attitude items, these were rated for relevance out of 10.

Attendees generally enjoyed Code Club and felt that they had learned coding skills. Many want to continue (Table 14).

Table 14: Code Club experience (N=66)

	Agree %	Disagree %	Not sure%
Code Club was fun	86	5	9
I would like to go to Code Club more in the future	65	14	21
I learned new coding skills at Code Club	86	6	8
I would rather do something else	17	55	27

Regression models predicting performance in coding quiz

Tables 15 to 18 present the R values for linear regression models, each based on two steps. The first model explains variation in the post-performance scores in the coding quiz controlling for pre-performance scores in the coding quiz (first step) and Code Club membership status (second step) at post-survey stage. Tables 15, 16 and 17 are similar, but predict the three primary learning attitude outcomes controlling for pre-survey attitudes. These models are not any test of causation, but do provide a caution about the strength and importance of the intervention in relation to pupil prior scores. Table 15 shows a small increase in R due to Code Club membership.

Table 15: Regression estimates for post quiz scores

Item	R	Standardised coefficient
Pre quiz score	0.60	0.57
Post Code Club membership	0.63	0.18

Table 16 shows R as an estimate of variation explained. In predicting the post-survey 'Resilience' *(I keep trying even when a task is difficult)* pre survey scores in this item and post-survey Code Club membership status are controlled for. There is no change in R which means no difference is made by knowing pupils' 'Code Club' membership status.

Table 16: Regression estimates for post-survey 'Resilience' *(I keep trying even when a task is difficult)*

Item	R	Standardised coefficient
Pre attitude score *(I keep trying even when a task is difficult)*	0.18	0.41
Post Code Club membership	0.18	0.03

Table 17 shows R as an estimate of variation explained. In predicting the post-survey 'Confidence to learn coding independently' *(I am good at learning coding by myself)* pre survey scores in this item and post-survey Code Club membership status are controlled for. There is no change in R which again means no difference is made by knowing pupils' 'Code Club' membership status.

Table 17: Regression estimates for post-survey 'Confidence to learn coding independently' *(I am good at learning coding by myself)*

Item	R	Standardised coefficient
Pre attitude score *(I am good at learning coding by myself)*	0.31	0.55
Post Code Club membership	0.31	0.01

Table 18 shows R as an estimate of variation explained. In predicting the post-survey 'Belonging' (*I know people like me who think coding is interesting)* pre survey scores in this item and post-survey Code Club membership status are controlled for. There is no change in R which means no difference is made by knowing pupils' 'Code Club' membership status.

Table 18: Regression estimates for post-survey 'Belonging' (*I know people like me who think coding is interesting)*

Item	R	Standardised coefficient
Pre attitude score (*I know people like me who think coding is interesting)*	0.25	0.40
Post Code Club membership	0.25	0.18

Missing cases from the post-survey

At the post survey stage 178 cases were missing. Descriptive analysis of the missing cases presents the average difference of pre-survey attitude and coding quiz scores between those who dropped out of the study and those who were retained. Table 19 presents the average differences of missing cases and their counterparts in pre-survey general learning attitudes. The differences are not large.

Table 19: Average of missing cases- Coding quiz and general learning attitudes

	Average Missing	Average Not missing
Pre-test coding quiz	7.16	7.96
Problem solving		
When I have a problem, I break it down into smaller problems to solve	5.19	5.25
I enjoy trying to solve problems	5.63	5.94
Resilience		
I keep trying even when a task is difficult	6.93	7.15
I do not like to spend time on difficult tasks	4.94	4.91
Communication		
I am good at explaining my ideas to other people	5.72	5.84
Creative thinking		
I like to ask questions that other people have not thought of	6.74	6.56
I like to suggest new ideas	6.81	6.77
Code Club Members	62	57
Total N	178	239

Table 20 presents the average differences of missing cases and their counterparts in pre-survey learning attitudes to coding.

Table 20: Average of missing cases- Attitudes to learning coding

	Average Missing	Average Not missing
Confidence to learn independently		
I feel confident when coding	6.29	6.41
I feel anxious when I am asked to write code	2.97	3.67
I am good at learning coding by myself	5.13	4.63
Belonging		
I know people like me who think coding is interesting	5.39	5.34
Interest		
I like coding	6.29	6.46
I like coding to solve problems	5.17	5.14
I want to learn more about coding	6.15	6.21
I like using coding to create projects	6.39	6.66
Total N	178	239

Tables 19 and 20 show that pupils who were retained in the study have slightly higher averages in coding quiz, general learning attitudes and attitudes to learning coding. This indicates a slight bias in the main findings of this study as these findings are based on only complete case analysis. Dropped out pupils could have changed the primary outcomes results, if included in the final survey and quiz. Therefore, the findings of the study should be interpreted with caution.

Process evaluation

The process evaluation was based on informal and semi-structured schedules and protocols for interviews, and Code Club sessions. The intention was to gather in-depth and narrative data from pupils, teachers and Code Club leaders who have experienced the activities. The perceptions of pupils, teachers and Code Club leaders, to some extent, could explain the underlying reasons and motivations

for voluntary participation. Pupils' experience and feedback on Code Club sessions could also indicate their learning choices and factors that can promote their wider learning process.

In the process evaluation eight Code Club leaders shared their experience of running after-school Code Club activities. During a Code Club observation visit we also talked with six pupils about their learning experiences. The sections below are combined themes of the recurring factors that emerged. In the data collection four trained researchers were involved who independently led these activities and provided data for synthesis.

A Code Club after-school session

We observed a Code Club session in which pupils engaged in a structured yet fun environment where they learn to code and work on various projects. The session comprised 15 primary school pupils including both boys and girls. While a class teacher was present, her role was more of a supportive nature, and she primarily assisted the Code Club leader in his efforts.

She commented on Code-Club after school activities as below:

> 'We are pleased to have this programme in our school for pupils who are interested in digital learning. We are placed in quite remote part of the region and this volunteering activity by the Code Club lead really helps our pupils to experience such activities which are more accessible in schools that are more centrally located.'

The session began with a warm welcome from the club leader, followed by pupils opening up the projects they are going to work on, often with the help of older pupils and class teacher. There was a brief introduction or recap of previous sessions, and the Code Club leader introduced the project coding concept. Participants then worked on coding projects that involved creating games, animations, or web pages using platforms like Scratch, Python, or HTML/CSS. These projects were designed to introduce coding concepts progressively, allowing pupils to build their knowledge and skills step by step.

Young coders wrote and tested their code, with guidance and support from the volunteers who helped, answered questions, and help troubleshoot any issues. Pupils were seen working together, sharing ideas and solutions in a collaborative environment that encouraged teamwork and peer learning. Towards the end of the session, pupils showed their projects to the group, demonstrating their learning and celebrating their achievements. The Code Club leader provided positive feedback, highlighted key learning points, and encouraged participants to reflect on what they learned, and discuss any challenges they faced.

Pupils interviewed in the session commented on their learning experiences as follows:

> 'Coding is really fun when I know what to do but sometimes it is hard but i always keep trying'

> 'Code Club gives me more knowledge of how-to code.'

> 'Coding is fun but is sometimes it is so hard as well.'

The session concluded with a summary of the session and next steps, and discussed additional resources and activities that pupils could try at home. There was time for informal social interaction, allowing participants to build friendships and enjoy a sense of community. These activities created a supportive and engaging learning environment where pupils could explore coding, developed digital learning skills, and expressed their creativity through technology.

Pupils commented on creating projects as below:

> ‘I am not a big fan of coding but I like making projects with coding.’
>
> ‘I enjoy coding a lot especially on Scratch it has very good sprites to help you create something’
> ‘I love creating animations.’
>
> ‘I like this session because I work on my own projects. I like creating my own games and animated movies.’

We observed that pupils primarily worked on their individual projects, and explored the Code Club platform and websites. Some of the older pupils were more experienced in coding than others, so the Code Club leader thoughtfully mixed the pupils with different levels of experience, facilitating a conducive environment for the more experienced coders to share their knowledge and skills with newcomers.

Each child had their individual projects to work on, promoting a sense of ownership and personalized learning. This setup encouraged active engagement and collaboration among the pupils. When they have completed the tasks, the Code Club leader recorded this, and gave feedback on that work.

Volunteering

In the interviews with Code Club leaders the most motivating experience to act as a volunteer was when they observed pupils exploring interests such as music, art, or electronics, and creating something they were proud of. This approach makes the experience meaningful and engaging. Volunteering with Code Club also provided a sense of purpose and fulfilment, allowing Code Club members to feel like valuable members of society, demonstrating that the benefits of the programme extended beyond the pupils to the volunteers as well.

> ‘…volunteering with Code Club has helped me feel I’m a useful member of society in my old age so the benefits have been good for me too.’

Independence in learning

Code Club leaders perceived that pupils became engaged, focused, and less disruptive. In the interviews several of them indicated that the club accommodates a mix of pupils including those who lack confidence, loners, and exceptionally smart kids. Informal learning is encouraged, with no strict rules. Pupils are motivated to complete tasks and be innovative, often choosing to work on their own projects and even continuing their efforts at home.

One of the comments was:

> ‘In my club pupil’s behaviour is very different from their normal classroom as the teacher says. In the club they are totally different, engaged, not disruptive. They are more focused. I have a child who lacks confidence, and he won a competition. It’s a mixture of kids. I have got loners as well. I have got some kids are super smart kids but in the normal classroom learning their actual potential is not recognised.’

Although the club is free and occasionally viewed as after-school care, Code Club leaders focus on designing engaging and interconnected sessions to sustain attendance.

> ‘Fortunately, we have ample resources and benefit from strong parental support. Pupils could access their work from home, enabling them to share their progress and projects with their families.’

All Code Club leaders commented on voluntary participation of pupils as a key ingredient of success in learning. This demonstrates their genuine interest and high level of engagement. Children's willingness to engage without compulsion highlights their enthusiasm for coding and innovation. By allowing them to select tasks and work on personal projects, Code Club cultivates an environment where pupils feel empowered to direct their own learning, enhancing both their technical skills and their self-confidence.

Mentoring and support

Mentoring and support can be important factors that motivate pupils and Code Club leaders to participate in this activity. Volunteers and club leaders provide guidance and encouragement, helping participants navigate challenges and develop their coding skills. This mentorship goes beyond technical instruction. It involves fostering creativity, problem-solving, and confidence. Support is tailored to individual needs, so that each child receives the attention necessary to progress at their own pace.

A Code Club member acting as a mentor commented:

> 'Younger kids learn very quickly. Once they understand the basic project they are working on they become independent very quickly. I just sometime help them and give ideas in using tools.'

A school leader who is also managing a Code Club commented:

> 'We invited pupils to participate in the Code Club and we received a good response from year 5 to 9 pupils who we knew had interest in computers and programming. Our Year 9 and 10 have been doing Code Club for about three years so we matched mentors for younger pupils. We found this very successful for pupil's social development and engagement.'

The value and role of mentoring and support was a dominant theme in these interviews. Volunteers and club leaders offered guidance and encouragement, assisting participants in navigating challenges and enhancing their coding skills. Beyond technical instruction, this mentorship focused on fostering learning attitudes and development of skills.

Friendship and confidence

Pupils and Code Club leaders stated that after-school clubs provided them with opportunities to engage in enjoyable activities with friends. They also found that school visits and club participation were occasions where they can form new friendships. They observed that traditional classroom activities often lack interactive elements that involve friends, whereas extracurricular activities allow them to collaborate with peers.

School leaders noted that participation in social actions and after-school clubs significantly boosts pupils' confidence in verbal communication. They have observed pupils taking initiative and assuming leadership roles, particularly in group projects, which strengthens their bonds of friendship. According to some school leaders, these activities showcase pupils' capabilities in roles that may not be apparent in traditional classroom settings.

Teachers provide support during these activities, but pupils largely lead their own activities. Achieving tasks independently contributes greatly to pupils' self-esteem, as they take ownership of their accomplishments. Working collaboratively in groups fosters trust among peers and further enhances their sense of camaraderie and friendship.

> ‘We see pupils in completely different roles when they are doing these Code Club activities. They enjoy more and you can see they have skills to do things that we otherwise don’t notice.’

> ‘In these Code Club activities, teachers are there to support and pupils lead their own social actions. It gives a lot of confidence to these pupils when they see any task successfully accomplished and they can actually own it in the end. This is what helps their self-esteem.’

> ‘Pupils see things achieved by themselves in Code Club. They work in groups and develop more trust and friendship when they do things on their own.’

Challenges

Code Club leaders were not all trained teachers, and they depend on support from school staff to assist them in running after-school programmes in the school premises. They sometimes reported difficulties arising when the school could not assign a staff member to support their activities. Another issue was the lack of information about certain pupils’ specific needs from school staff.

Internet resources and availability of computers, laptops or other technological devices to log in to the Code Club platform was also mentioned.

> ‘Connectivity issues with the internet have also impacted our activities in the past, though recent experiences have been more reliable.’

Most schools were well-equipped with all of the necessary resources to ensure the success of the clubs. However, in the feedback from the community library Code Club leader, in their experience of several settings, the libraries were described as not as well-supported as schools can be. The equipment and resource rooms in the libraries were reported as sparse and the clubs do not have high participation from the local community members. The level of participation and engagement of pupils also depend on parents’ involvement.

Volunteering Code Club leaders could be university students. One of Code Club leader was a graduate, running a Code Club for a local school was his extra-curricular activity. He stated that travelling to school for this activity can be challenging because of the remote location of the school. The buses are not on time, so it takes a lot of his time in management of travelling. It is also costly to travel to schools for volunteering.

Conclusion

Summary

Code Club, overseen by the Raspberry Pi Foundation (RPF), is a volunteer-led initiative offering after-school programs aimed at pupils aged 9 to 13, providing them with opportunities to learn and hone coding skills. RPF supports these Code Clubs by supplying free resources, projects, and advice to encourage learning coding. They also develop structured curricula designed to make coding accessible and enjoyable. Participants create their own digital projects during club sessions, fostering a fun, informal, and collaborative learning environment. Volunteers lead Code Club activities on-site, dedicating their time to running after-school sessions. Code Club leaders oversee the after-school clubs, supported by RPF in implementation and organisation.

We have evaluated the impact of Code Club on pupils' attitudes towards learning in general, their specific interest in coding, and their performance in coding skills, through a quasi-experiment involving 18 schools and 1 community library. Initially targeting 412 pupils in Years 4 to 9, the evaluation compares Code Club members with peers who did not participate in these activities.

The evaluation assesses outcomes using pre- and post-intervention measures of non-cognitive learning attitudes and coding quiz performance. Results focus on gains observed in pupils' learning attitudes and quiz scores. Additionally, a light-touch process evaluation examines aspects such as reasons for and levels of pupil participation, Code Club leaders' motivations and experiences, as well as challenges encountered in running clubs across schools and community libraries.

Code Club students were generally older, and there were more cases in the comparator group (the group being compared against the Code Club participants). This imbalance could introduce confounding variables that affect the interpretation of outcomes.

To mitigate some of the study's weaknesses, the evaluation emphasises analysing progress scores rather than absolute outcomes. This approach attempts to highlight changes or improvements over time within each group. Pupils reported joining Code Club primarily because of their interest in coding and enjoyment of the experience. This reflects a positive initial motivation among participants.

Despite positive findings in both attitudes and coding skills, differences observed between groups were sometimes small and might be considered negligible in practical terms. Sensitivity tests were conducted to assess the robustness of these findings to variations in the analysis.

Interpretation

Participation in after-school Code Club activities has been beneficial for pupils in multiple ways. Firstly, it appears to have positively influenced their attitudes towards learning in general, fostering qualities like resilience. Moreover, pupils have shown increased confidence and a sense of belonging, in relation to coding tasks. Beyond these expected outcomes, there has been notable improvement in other skills such as problem-solving, communication, and creative thinking, which were not initially targeted but have emerged as secondary outcomes of the club activities.

Furthermore, pupils' performance in quizzes assessing their coding skills has shown promising results, indicating that their learning in Code Club translates into measurable proficiency.

Code Club operates led by dedicated leaders who ensure enjoyable experiences for participating pupils. School premises appear to be popular and active venues for these activities, where pupils engage enthusiastically. Conversely, the community library hosting Code Club reported lower attendance among young people, highlighting varying levels of engagement perhaps depending on the venue.

Overall, the enthusiasm and enjoyment expressed by young participants in after-school Code Club sessions underscores their engagement in coding and their passion for developing creative digital projects. The approach not only enhances technical skills but also nurtures a positive learning environment that promotes broader personal and cognitive growth.

Limitations

Code Club members showed expected improvements in coding skills and in broader attitudes toward learning, problem-solving, and coding itself. However, some specific attitude items showed less improvement than anticipated. The extent or "dosage" of Code Club participation and its impact remains unclear from the evaluation. This means the study could not definitively establish how much or how little participation influenced outcomes.

The findings from the quasi-experiment show moderate to low confidence levels across all measured outcomes. The study was conducted at a large scale, involving regular implementation of Code Clubs as after-school activities. Initially, the pre-test stage included participation from 18 schools and 1 community library, providing a sample of 417 pupils. However, by the post-test stage, only 13 schools and 239 pupils could be retained and linked for complete analysis.

The dropout rate is noteworthy because it affects the reliability of the study's findings. High dropout rates introduced bias and impact the representativeness of the final sample analysed. Despite efforts to maintain consistency in implementing Code Clubs, the attrition of participants raises questions about the generalisability of the results to the broader population of students initially involved in the study. Therefore, while the findings provide valuable insights into the impact of Code Clubs, particularly on those who remained in the study, caution is warranted in draw conclusions from these results more broadly.

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APPENDIX A
Pupil Attitude Survey and Coding Quiz

APPENDIX B – additional results and analyses, including for cases completing pre-test or post-test only

The whole sample

For individual pupils we calculated gains by subtracting pre scores from post scores and present the average gain and standard deviation of the whole group (Code Club and not in Code Club) in Tables B1 and B2.

General learning attitudes

Table B1: General learning attitudes, all pupils (N=248)

	Gain Average	Standard Deviation
Problem solving		
When I have a problem, I break it down into smaller problems to solve	-5.20	4.44
I enjoy trying to solve problems	-0.06	3.28
Resilience		
I keep trying even when a task is difficult	-0.31	3.18
I do not like to spend time on difficult tasks	0.25	4.26
Communication		
I am good at explaining my ideas to other people	-0.25	3.21
Creative thinking		
I like to ask questions that other people have not thought of	-0.24	3.85
I like to suggest new ideas	-0.05	3.70

Table B1 shows that all pupils have declined in the general attitude to learning. The item on resilience, 'I do not like to spend time on difficult tasks', shows positive gains average but it is a negative prompt item therefore positive gains should interpret as negative.

Attitudes to learning coding
Table B2 shows average gains of the whole group in attitude to learning coding.

Table B2: Attitude to learning coding, all pupils (N=248)

	Gain Average	Standard Deviation
Confidence to learn independently		
I feel confident when coding	-0.75	3.01
I feel anxious when I am asked to write code	0.26	3.45
I am good at learning coding by myself	-0.25	3.21
Belonging		
I know people like me who think coding is interesting	-0.47	3.81
Interest		
I like coding	-0.75	3.15
I like coding to solve problems	-0.13	3.41
I want to learn more about coding	0.33	2.30
I like using coding to create projects	-0.91	3.72

Again, there is a decline in attitudes to learning coding except for one item in interest in learning coding, 'I want to learn more about coding.', which might be sated by attending Code Clubs. The item about confidence in coding, 'I feel anxious when I am asked to write code' is negative therefore positive gains should be interpreted as a negative result.

Pre-test results only

There were 417 respondents at the start of the intervention, 117 of whom reported being in a Code Club. The latter were, unsurprisingly, better at coding already, scoring higher in the programming quiz (Table B3).

Table B3 – Comparison of programming skills by group, pre-test

	Mean score	Standard deviation	"effect" size
Code Club	9.74	4.50	+0.66
Not known to be Code Club	6.84	4.04	
Overall	7.65	4.37	

Those already in Code Club were already reporting being more experienced in using all three languages used in the programming quiz (Table B4).

Table B4 – Use of programming languages by group, pre-test

	Code Club %	Not Code Club %	Odds ratio
Scratch			
No response	6.8	3.7	
Never used it	6.0	12.0	2.07
Not often use it	12.0	15.3	
Sometimes use it	57.3	64.7	
Everyday use	17.9	4.3	
Python			
No response	8.5	6.0	
Never used it	49.6	73.0	2.94
Not often use it	26.5	17.3	
Sometimes use it	14.5	3.7	
Everyday use	0.9	0	
HTML			
No response	12.0	6.7	
Never used it	67.5	75.7	1.30
Not often use it	12.8	9.0	
Sometimes use it	6.0	6.7	
Everyday use	1.7	2.0	

Note: odds ratios compare "any use" to "never used"

In terms of attitudes, Code Club members were more positive about learning and problem-solving in general, and about coding (Table B5). They were ahead in the three items pre-selected by RPF as headline indicators (in bold) – resilience (0.29), independence (0.51), and belonging (0.85). There are some negative "effect" sizes, but these are for negatively coded items.

Table B5 – Comparison of attitude items by group, pre-test

	Code Club	Not Code Club	Standard deviation	"effect" size
Problem solving				
When I have a problem, I break it down into smaller problems to solve	5.98	4.95	2.94	+0.35
I enjoy trying to solve problems	6.61	5.53	3.29	+0.33
Resilience				
I keep trying even when a task is difficult	7.63	6.86	2.68	+0.29
I do not like to spend time on difficult tasks	4.81	4.97	3.30	-0.05
Communication				
I am good at explaining my ideas to other people	6.35	5.60	3.16	+0.24
Creative thinking				
I like to ask questions that other people have not thought of	7.14	6.44	3.06	+0.23
I like to suggest new ideas	7.47	6.52	3.18	+0.30
Confidence to learn independently				
I feel confident when coding	8.48	5.57	3.02	+0.96
I feel anxious when I am asked to write code	2.54	3.74	3.19	-0.38
I am good at learning coding by myself	6.13	4.43	3.34	+0.51
I get on well with others while learning coding in a group	7.99	6.46	2.97	+0.52
Belonging				
I know people like me who think coding is interesting	7.60	4.51	3.63	+0.85
Interest				
I like coding	8.98	5.42	3.52	+1.01
I like coding to solve problems	7.42	4.29	3.37	+0.93
I want to learn more about coding	8.79	5.20	3.67	+0.98
I like using coding to create projects	8.86	5.69	3.51	+0.90

At pre-test, 19 of the respondents said that they had been a member of a Code Club at some time in the past. 16 of these also reported being a member of Code Club at pre or post or both, and these are handled as standard in the main analysis. The remaining 3 all made considerable negative progress in the quiz (average -3.0, compared to an overall average of -0.11).

Post-test only

There were 312 respondents in the post-intervention survey and quiz, of which only 73 reported being members of Code Club (Table B6). As at pre-test, the Code Club members scored higher on the programming quiz.

Table B6 – Comparison of programming skills by group, post-test

	Mean score	Standard deviation	"effect" size
Code Club	10.53	3.59	+0.87
Not known to be Code Club	7.23	3.49	
Overall	8.00	3.78	

Those in Code Club at the second survey reported being more experienced in using all three languages used in the programming quiz (Table B7).

Table B7 – Use of programming languages by group, post-test

	Code Club %	Not Code Club %	Odds ratio
Scratch			
No response	1.4	4.0	
Never used it	4.1	10.3	2.77
Not often use it	6.8	20.2	
Sometimes use it	46.6	60.7	
Everyday use	41.1	4.8	
Python			
No response	2.7	6.0	
Never used it	28.8	65.9	5.56
Not often use it	52.1	23.0	
Sometimes use it	16.4	4.4	
Everyday use	0	0.8	
HTML			
No response	9.6	7.9	
Never used it	61.6	73.8	2.01
Not often use it	17.9	11.1	
Sometimes use it	8.2	6.0	
Everyday use	2.7	1.2	

By the second survey, the differences between groups in terms of general attitudes to learning and problem-solving are smaller (Table B8). This reinforces the idea that participants in Code Club before the intervention were more motivated (as those who chose to take part). The "effect" sizes relevant to coding are larger than at pre-test however. This could be an outcome of participating in Code Club, or a further self-selection bias.

Table B8 – Comparison of attitude items by group, post-test

	Code Club	Not Code Club	Standard deviation	"effect" size
Problem solving				
When I have a problem, I break it down into smaller problems to solve	5.02	4.76	3.00	0.09
I enjoy trying to solve problems	7.27	5.02	3.34	0.67
Resilience				
I keep trying even when a task is difficult	7.67	6.18	2.99	0.50
I do not like to spend time on difficult tasks	4.14	5.32	3.55	-0.33
Communication				
I am good at explaining my ideas to other people	5.52	5.13	3.18	0.12
Creative thinking				
I like to ask questions that other people have not thought of	7.69	5.52	3.36	0.65
I like to suggest new ideas	7.93	5.94	3.12	0.64
Confidence to learn independently				
I feel confident when coding	9.00	4.38	3.52	1.31
I feel anxious when I am asked to write code	2.41	4.14	3.30	-0.52
I am good at learning coding by myself	7.31	3.43	3.34	1.16
Belonging				
I know people like me who think coding is interesting	8.26	3.63	3.67	1.26

Interest				
I like coding	9.38	4.43	3.76	1.32
I like coding to solve problems	8.00	3.73	3.47	1.23
I want to learn more about coding	9.24	4.44	3.85	1.25

As noted in the main text, the item "I get on well with others while learning coding in a group" used in the pre-test was removed from the post-test, and so does not appear in Table B8.

APPENDIX C - Programming languages

Here we summarise differences between groups and changes over time. Table C1 shows that at the outset Code Club members were already more familiar with Scratch, Python and HTML coding.

Table C1 – Use of programming languages by group, pre-test

	Code Club	Not Code Club	Odds ratio
Scratch			
No response	6.8	3.7	
Not often use it	12.0	15.3	
Never used it	6.0	12.0	2.07
Everyday use	17.9	4.3	
Sometimes use it	57.3	64.7	
Python			
No response	8.5	6.0	
Not often use it	26.5	17.3	
Never used it	49.6	73.0	2.94
Everyday use	0.9	0	
Sometimes use it	14.5	3.7	
HTML			
No response	12.0	6.7	
Not often use it	12.8	9.0	
Never used it	67.5	75.7	1.30
Everyday use	1.7	2.0	
Sometimes use it	6.0	6.7	

Note: odds ratios compare any use to never used

Table C2 shows that this familiarity with all three languages has increased by the time of the second survey.

Table C2 – Use of programming languages by group, post-test

	Code Club	Not Code Club	Odds ratio
Scratch			
No response	1.4	4.0	
Not often use it	6.8	20.2	
Never used it	4.1	10.3	2.77
Everyday use	41.1	4.8	
Sometimes use it	46.6	60.7	
Python			
No response	2.7	6.0	
Not often use it	52.1	23.0	
Never used it	28.8	65.9	5.56
Everyday use	0	0.8	
Sometimes use it	16.4	4.4	
HTML			
No response	9.6	7.9	
Not often use it	17.9	11.1	
Never used it	61.6	73.8	2.01

Everyday use	2.7	1.2	
Sometimes use it	8.2	6.0	

The average gain score for the programming quiz was -0.11. Tables C3 and C4 compare the gain scores in the quiz for those who reported using each platform/language every day and sometimes. The number of people using each language remained very similar pre and post. The number reporting using HTML at the outset is perhaps a mistake (173). People using each of these languages regularly tend to have gain scores above average, except those reporting using Scratch at the outset. At post-test the advantages of regular use of Python, in terms of quiz scores, is not clear. The small number using HTML at post-test seem to make the most progress.

Table C3 – gain scores in programming quiz, by use of language sometimes

	N pre	Sometimes pre	N post	Sometimes post
Scratch	150	0.01	149	-0.04
Python	16	0.63	138	0.19
HTML	173	0.60	12	0.50

Table C4 – gain scores in programming quiz, by use of language every day

	N pre	Every day pre	N post	Every day post
Scratch	19	0.95	20	1.20
Python	0	-	1	0.00
HTML	4	2.25	5	1.60

There are not enough cases at post-test to do further sub-analyses here.